

SUPPORT FOR THE AMENDMENT

This Amendment cancels Claims 7-11; amends Claims 1, 4-6 and 12-18; and adds new Claim 19. Support for the amendments is found in the specification and claims as originally filed. In particular, support for Claim 1 is found in the specification at least at page 10, lines 13-27 and in canceled Claim 3. The limitation "consists essentially of" excludes from the titanium material unspecified ingredients that would materially effect the secular discoloration resistance of the titanium material. Support for new Claim 19 is found in Claim 14. No new matter would be introduced by entry of these amendments.

Upon entry of these amendments, Claims 1, 4-6 and 12-19 will be pending in the present application. Claim 1 is independent. Claims 6-16 are withdrawn from consideration pursuant to Restriction Requirement.

REQUEST FOR RECONSIDERATION

Applicants respectfully request entry of the foregoing and reexamination and reconsideration of the application, as amended, in light of the remarks that follow.

The present invention provides a pure titanium material more resistant to secular discoloration than conventional titanium materials. Specification at page 3, lines 8-10. The present inventors discovered that an excessive amount of Fe, Nb and Co in pure titanium causes the development of secular discoloration of the titanium. Specification at page 7, lines 7-10. In addition, the present inventors have discovered that when the pure titanium has a surface oxide film of 170 Å or below in thickness the pure titanium is not subject to secular discoloration to an extent that spoils aesthetic design, but instead maintains a desirable silver appearance. Specification at page 4, lines 23-27. The surface oxide film grows when the titanium is exposed to oxygen contained in the atmosphere during an annealing process and is removed by pickling. Specification at page 8, lines 20-23.

To form the surface oxide film having improved secular discoloration resistance, the pure titanium having Fe, Nb and Co below specified levels undergoes a finishing process that significantly influences the surface properties of the titanium. Specification at page 9, lines 22-25. The surface oxide film of a titanium material finished by a vacuum annealing process contains a large amount of carbon, which causes secular discoloration. Specification at page 10, lines 2-4. To avoid secular discoloration, the present invention relies upon a pickling process to finish the titanium. Specification at page 10, lines 4-6.

When the surface of a workpiece is treated by pickling in the finishing process, a titanium material having high secular discoloration resistance can be obtained by subjecting the pickled workpiece to a heat treatment process that heats the pickled workpiece at a temperature X ($^{\circ}\text{C}$) in the range of 130 to 280 $^{\circ}\text{C}$ for a heating time T (min) so as to meet a condition expressed by: $T \geq 239408 \times X^{-2.3237}$. Specification at page 10, lines 13-19.

Although the reasons why the heat treatment process improves the secular discoloration resistance is not clearly known, it is considered that the heat treatment process changes the construction of the oxide film. Specification at page 10, lines 24-27.

The significant improvement in secular discoloration resistance that is achieved by the present invention is shown in the specification at Tables 3-4, reproduced below.

Table 3

Heating process	Heating conditions			$239408 \times X^{2.3237}$
	Heating temperature (°C)	Soaking time (min)		
(A)	130	3	Atmospheric	2.93
(B)	130	20	Atmospheric	2.93
(C)	130	60	Atmospheric	2.93
(D)	130	120	Atmospheric	2.93
(E)	200	1.1	Atmospheric	1.08
(F)	200	20	Atmospheric	1.08
(G)	200	60	Atmospheric	1.08
(H)	200	120	Atmospheric	1.08
(I)	280	0.5	Atmospheric	0.49
(J)	280	20	Atmospheric	0.49
(K)	280	60	Atmospheric	0.49
(L)	280	120	Atmospheric	0.49
(M)	130	120	Vacuum	2.93
(N)	200	120	Vacuum	1.08
(O)	280	120	Vacuum	0.49
(P)	130	2	Atmospheric	2.93
(Q)	200	<u>0.5</u>	Atmospheric	1.08
(R)	280	<u>0.2</u>	Atmospheric	0.49
(S)	280	150	Atmospheric	0.49

Table 4

Specimen No.	Fe content (% by mass)	Nb content (% by mass)	Co content (% by mass)	Finishing process	Heat treatment process	ΔE^*
46	0.06	0.001	0.001	Pickling	(A)	0.4
47	0.06	0.001	0.001	Pickling	(B)	0.4
48	0.06	0.001	0.001	Pickling	(C)	0.3
49	0.06	0.001	0.001	Pickling	(D)	0.3
50	0.06	0.001	0.001	Pickling	(E)	0.4
51	0.06	0.001	0.001	Pickling	(F)	0.3
52	0.06	0.001	0.001	Pickling	(G)	0.3
53	0.06	0.001	0.001	Pickling	(H)	0.2
54	0.06	0.001	0.001	Pickling	(I)	0.3
55	0.06	0.001	0.001	Pickling	(J)	0.3
56	0.06	0.001	0.001	Pickling	(K)	0.2
57	0.06	0.001	0.001	Pickling	(L)	0.2
58	0.06	0.001	0.001	Pickling	(M)	0.4
59	0.06	0.001	0.001	Pickling	(N)	0.3
60	0.06	0.001	0.001	Pickling	(O)	0.3
61	0.03	0.001	0.001	Pickling	(A)	0.3
62	0.03	0.001	0.001	Pickling	(B)	0.2
63	0.03	0.001	0.001	Pickling	(C)	0.2
64	0.03	0.001	0.001	Pickling	(D)	0.2
65	0.03	0.001	0.001	Pickling	(E)	0.2
66	0.03	0.001	0.001	Pickling	(F)	0.2
67	0.03	0.001	0.001	Pickling	(G)	0.2
68	0.03	0.001	0.001	Pickling	(H)	0.1
69	0.03	0.001	0.001	Pickling	(I)	0.2
70	0.03	0.001	0.001	Pickling	(J)	0.1
71	0.03	0.001	0.001	Pickling	(K)	0.1

72	0.03	0.001	0.001	Pickling	(L)	0.1
73	0.03	0.001	0.001	Pickling	(M)	0.2
74	0.03	0.001	0.001	Pickling	(N)	0.2
75	0.03	0.001	0.001	Pickling	(O)	0.2
76	0.06	0.001	0.001	Pickling	(P)	0.7
77	0.06	0.001	0.001	Pickling	(Q)	0.7
78	0.06	0.001	0.001	Pickling	(R)	0.7
79	0.06	0.001	0.001	Pickling	(S)	0.1
80	0.03	0.001	0.001	Pickling	(P)	0.6
81	0.03	0.001	0.001	Pickling	(Q)	0.6
82	0.03	0.001	0.001	Pickling	(R)	0.6
83	0.03	0.001	0.001	Pickling	(S)	0

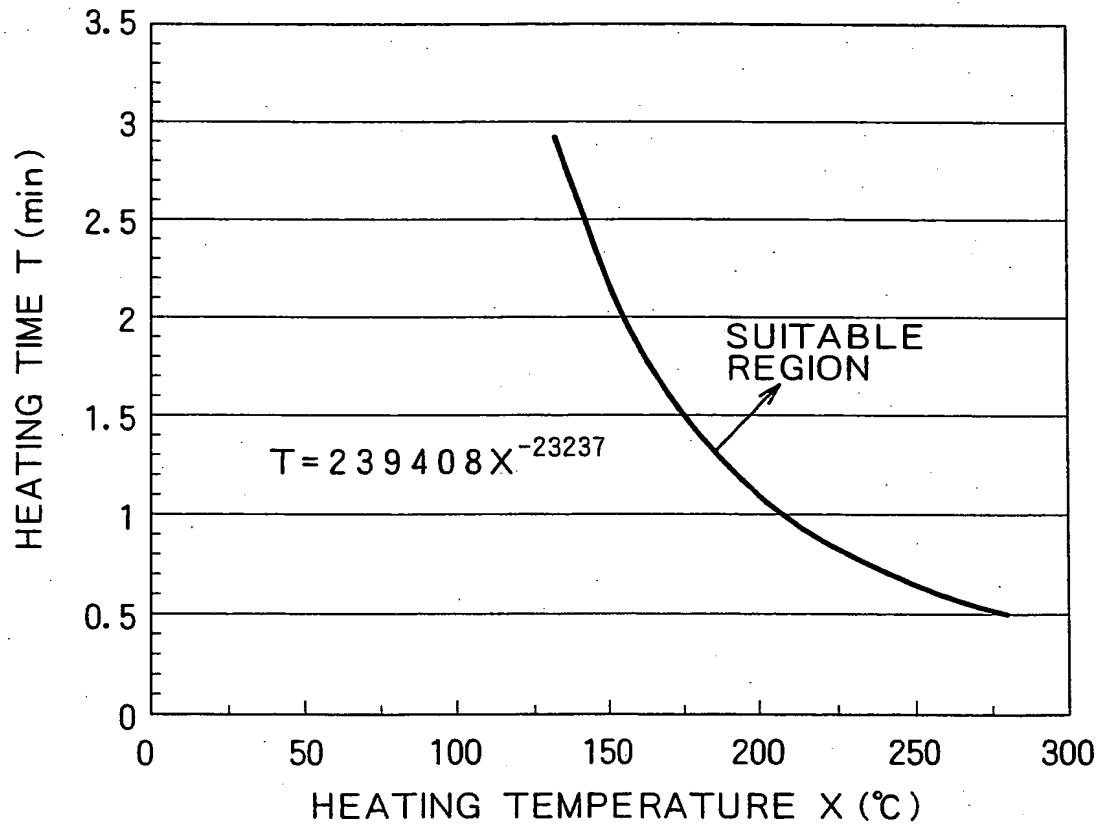
In Table 3, Heating Processes P, Q and R, at 130, 200 and 280°C, respectively, were carried out at soaking times that **did not satisfy** the relation $T \geq 239408 \times X^{-2.3237}$. Table 4 shows that Specimen Nos. 76-78 and 80-82, which underwent one of Heating Processes P, Q and R, respectively, each exhibits an inferior color difference ΔE^* **that is greater than 5**.

A smaller color difference corresponds to a smaller degree of discoloration. When ΔE^* that less than 5, it is judged that secular discoloration is sufficiently suppressed. Specification at page 13, lines 23-25.

In Table 3, Heating Processes A-O and S, at 130, 200 and 280°C, respectively, were carried out at soaking times that **did satisfy** the relation $T \geq 239408 \times X^{-2.3237}$. Table 4 shows that Specimen Nos. 46-75, 79 and 83, which underwent one of Heating Processes A-O and S, respectively, each exhibits a color difference ΔE^* **that is less than 5**.

Tables 3-4 show that pickling a pure titanium material having Fe, Nb and Co less than the amounts specified by the present invention, followed by heating the pickled titanium so as to satisfy the relation $T \geq 239408 \times X^{-2.3237}$, results in a surface oxide film on the titanium with structural characteristics that provide significantly improved secular discoloration resistance. The relation $T \geq 239408 \times X^{-2.3237}$ is shown graphically in Fig. 2, reproduced below.

FIG. 2



Claims 1 and 4-5 are rejected under 35 U.S.C. § 102(b) over by XP 00227868 ("XP-686"), optionally in view of ASM Handbook, vol. 2, page 1169 ("ASM").

Claims 17-18 are rejected under 35 U.S.C. § 103(a) over XP-686, optionally combined with ASM.

Claims 1, 4-5 and 17-18 are rejected under 35 U.S.C. § 103(a) over JP 09-003573 ("JP-573").

Claims 1, 4-5 and 17-18 are rejected under 35 U.S.C. § 103(a) over XP-686 and ASM, or JP-573, in view of JP 10-008234 ("JP-234").

Claims 1 and 4-5 are rejected under 35 U.S.C. § 103(a) over XP-686 and optionally in view of ASM.

XP-686 discloses high purity electrolytic titanium containing 0.009% Fe and iodide titanium containing 0.002% Fe. XP-686 discloses that an oxide film can form on titanium that leads to changes in surface color.

ASM discloses electrolytic titanium and iodide titanium having a Fe impurity limit of 0.009% and 0.002%, respectively.

JP-573 discloses pure titanium containing, by weight, Fe, Ni, and Cr in amounts satisfying $100 \leq \text{Fe} \leq 600$, $100 \leq \text{Ni} + \text{Cr} \leq 700$, and $\text{Fe} + \text{Ni} + \text{Cr} \leq 1000$ (unit: ppm), and also containing inevitable impurities. English-language machine translation of JP-573 at abstract.

The Final Rejection at page 2, line 11; page 4, line 6; and page 5, line 8, admits that each of XP-686 and JP-573 "does not mention the presence of Co or Nb".

In addition, The Final Rejection at page 4, line 17, states that "[n]either JP-573 nor XP-686 mention the formation of an oxide coating".

JP-234 discloses preventing the generation of discoloration of outdoor titanium over a long period of time by regulating the surface roughness of the titanium to $\leq 3 \mu\text{m}$ by the

center line average roughness Ra and by regulating the thickness of the oxidized coating on the surface to $\geq 20 \text{ \AA}$. English-language machine translation of JP-234 at abstract.

However, the cited prior art fails to disclose or suggest the structural features, providing improved secular discoloration resistance, of independent Claim 1's "surface oxide film" that are implied by the Claim 1 limitation that "the titanium material is produced by a process that includes a finishing process comprising pickling the titanium; and heating the pickled titanium at a temperature X ($^{\circ}\text{C}$) in a range of from 130°C to 280°C for a time T (minutes) so that $T \geq 239408 \times X^{-2.3237}$ ". See MPEP § 2113. As discussed above, "[a]lthough the reason why the heat treatment process improves the secular discoloration resistance is not clearly known, it is considered that the heat treatment process changes the construction of the oxide film". Specification at page 10, lines 24-27.

Because the cited prior art fails to disclose or suggest all of the structural features of independent Claim 1, both explicit and implicit, the prior art rejections should be withdrawn.

Pursuant to MPEP § 821.04, after independent product Claim 1 is allowed, Applicants respectfully request, rejoinder, examination and allowance of withdrawn method Claims 6-16, which include all of the limitations of product Claim 1.

In view of the foregoing amendments and remarks, Applicants respectfully submit that the application is in condition for allowance. Applicants respectfully request favorable consideration and prompt allowance of the application.

Should the Examiner believe that anything further is necessary in order to place the application in even better condition for allowance, the Examiner is invited to contact Applicants' undersigned attorney at the telephone number listed below.

Respectfully submitted,

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